Effect of Natural and Unnatural Debris on Habitat Preference in Fathead Minnows

An Honors Thesis (HONR 499)

By

Caitlin Hoover

Thesis Advisor

Dr. Mark Pyron

Ball State University
Muncie, Indiana

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Abstract

Cyprinid fishes are an important part of many freshwater aquatic ecosystems. Therefore, knowledge of minnow habitat and behavior can be important to many other species. In this study the objective was to determine if minnows preferred a debris filled habitat or an open habitat and determine if the use of natural and unnatural debris affected this choice. During the study two experimental tanks were half filled with debris. One received natural debris and the other unnatural debris. Observations of groups of ten fathead minnows were recorded for each tank and the data was analyzed using a t-test. The results were not significant. However, due to the small sample size more research is needed to validate these results.

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I would like to Thank Dr. Mark Pyron for advising me during this project. He answered any questions I had and continued to help even when the project ran past the end of the semester.

I would also like to thank Cameron for emotional support and helping with transportation.

Process Analysis Statement

This thesis process was far more difficult than I thought it would be when I started. I thought I had enough experience from my course work that an independent research project would be easy, but I still feel I need more practice and experience before I become completely comfortable applying the scientific process outside of a classroom. This is not to say that I was completely unprepared for this project. Through my college career and in particular through my biology courses I have planned out and conducted several research projects. However, all of my previous projects involved group members that I could share the work with. When working on my own for this project I realized just how repetitive and time consuming a research project can be. This project focused heavily on observations and I had to go to the research greenhouse on many occasions and just sit for an hour making observations. Some days I didn't want to sit in the greenhouse for an hour, but I had to be disciplined enough to push through and do what was necessary to collect my data. I now have a much greater respect for other researchers who spend years collecting data sometimes in conditions far less comfortable than a greenhouse. However, this is not to say the process was entirely unenjoyable. I enjoyed planning the project and I enjoyed creating my micro-environments in the tanks. I also enjoyed working with the minnows. I choose zoology, because I love animals and working with live minnows was enjoyable.

My process began with picking my topic which with the help of Dr. Pyron was relatively easy. I had previously worked in the environmental research greenhouse while doing a group project in Dr. Pyron's ichthyology class and was familiar with the basics of working with minnows. Therefore, I decided to extend on my previous experiences and do a research project on minnows based primarily in observations. After, I picked my topic things became slightly more difficult as a figured out some of the finer details such as how many minnows should be in each experimental group. With Dr. Pyron's help I worked out my exact research plan and began

to work in the environmental studies greenhouse. However, before I could begin observations I had to collect my minnows and clean the research tanks. Unfortunately, my first attempt to collect minnows with Dr. Pyron did not go well because the white river was still ice cold and the minnows were all hunkered down making them hard to catch. We only caught a few minnows and I would need dozens to complete my project. However, I continued to work on my project by cleaning my tanks. My next attempt to collect minnows was made impossible by large amounts of rain and high water levels. At this point it was getting late in the semester so Dr. Pyron suggested I use bait fish minnows as they were easy to obtain and would allow me to start making observations. The observations themselves were an easy process and I was easily able to make trips to the greenhouse after my other classes. However, I ran into several setbacks that come along with working with live animals. My minnows in one of my research tanks died and I had to clean and reset the tanks due to algae growth on more than one occasion. These were all setbacks I should have planned for, but due to my lack of experience I was unprepared for the extra time these setbacks would require. However, I was thankfully able to extend my research for a few week and collect enough data to come to a conclusion. The next step in my process was writing my report. I am familiar with this process, but I have never particularly enjoyed this important part of the scientific process. I found it difficult, but rewarding to use the skills I had learned in my classes to write up my report.

Overall, I am proud that I persevered and completed this process even though it was challenging at times. I feel like the most rewarding part was being able to apply the skills I learned in my classes, proving that I actually learned useful skills. The most challenging part was by far keeping myself motivated. I have always been someone who does not do well creating their own deadlines. In the end this caused me start my project later then I should have causing me run out of time. Procrastination has always been a struggle of mine and is something I still need to work on. However, despite my struggles I still created a finished project. My project shows that even a simple research project involves more work than most people think and that scientists have a very important and sometimes very challenging job. I know that my personal experiences with this project have taught me some important lessons and made me a better zoologist. Even though I would have preferred a smooth process I think my challenges help me learn more and made finally finishing more rewarding.

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Introduction

When foraging animals select between areas with greater food resources, but more risk of predation and areas with fewer resources, and less chance of predation (Gilliam and Fraser 1987). The amount of cover in an area can be one of the factors that determines the amount of predation risk and food resources. Wood debris can have a positive effect on food abundance by providing habitat for invertebrates, bacteria, and fungi (Triska et al. 1984, Shearer 1972, Anderson et al. 1978). Woody debris can also provide cover and refugia to some fishes including cyprinid minnows (Langford et al. 2012). However, habitat preference can also be affected by the type of predators in the area, with minnows frequently preferring open areas to avoid agile predators and covered areas to avoid less agile predators (Savino and Stein 1989).

In many agricultural watersheds small streams are channelized reducing or eliminating large woody debris. Channelization has a negative effect on overall stream diversity and reduces habitat availability (Lau et al. 2006, Sullivan et al. 2004). This can affect a wide number of species of both predator and prey. Minnows may benefit from woody debris and other cover and are an important part of most aquatic food webs (Savino and Stein 1989). Therefore, habitat availability for minnows can affect numerous other species. Some minnow species prefer woody debris for cover (Langford et al. 2012). However, in an urban area unnatural debris such as plastic bags and plastic jugs may be a common source of debris. Studies of freshwater plastic pollution are rare, but Morritt et al. (2013) a study in the Thames River showed that over 8,000 plastic items were recovered from seven locations.

My goal was to determine if fathead minnows (*Pimephales promelas*) have a habitat preference for large debris in comparison to open areas. Additionally, the goal was to determine if unnatural debris such as plastic containers are used for cover as commonly as natural debris. My hypothesis was that fish will prefer the habitat with debris as it provides more cover and security. Additionally, the fish may prefer the unnatural debris as well, as long as they still provide cover.

Methods

Fathead minnows were purchased from a local Muncie, IN bait shop. Minnows ranged in size from 40 to 70 mm in length. Minnows were allowed 24 hours to acclimate to the temperature of the research greenhouse at Ball State University. Minnows were then placed in a holding tank and feed frozen blood worms every two to three days during the time span of the experiment. Experimental tanks were 1.3 m in diameter and contained treated tap water approximately 30-40 cm in depth. In the "natural" tank half of the tank was filled with natural debris, large rocks and branches collected from the White River and Christy Woods, Delaware County, Indiana. The other half of the tank was empty of any debris or substrate. In the "unnatural" tank half of the tank was filled with unnatural debris, empty one-gallon plastic containers, bricks and plastic bags. The other half of the tank was empty of any debris or substrates. All other variables including light and water temperature were the same for both tanks. For each trail ten minnows were added to the experimental tanks and allowed 24 hours to acclimate to their environment. After the acclimation period the minnows were observed for

a period of one hour with observations made every 10mins, for seven total observations. Observations were made from a distance of approximately 1vm to minimize startling the minnows. Each observation was a count of the number of fish on each half of the tank. Two one hour observations were made over the course of two days for each trial. After each trail fish were euthanized and the process was repeated with different individuals. A total of 6 trails were conducted for the natural tank and 5 trials were conducted for the unnatural tank (loss of data due to minnow death). The process was the same for both tanks. The mean number of observation for open/debris for each trail was calculated for both experimental groups. Then a pooled variance two-sample t-test was used to compare the mean values of open/debris occurrences (Minitab 17).

Results

There was no significant difference in mean number of fishes using the two habitat types (Figure 1). There was no difference between minnow occurrence in regard to the choice of natural debris and open habitat (p=0.050). There was no difference between minnow occurrence in regard to the choice of unnatural debris and open habitat (p=0.757).

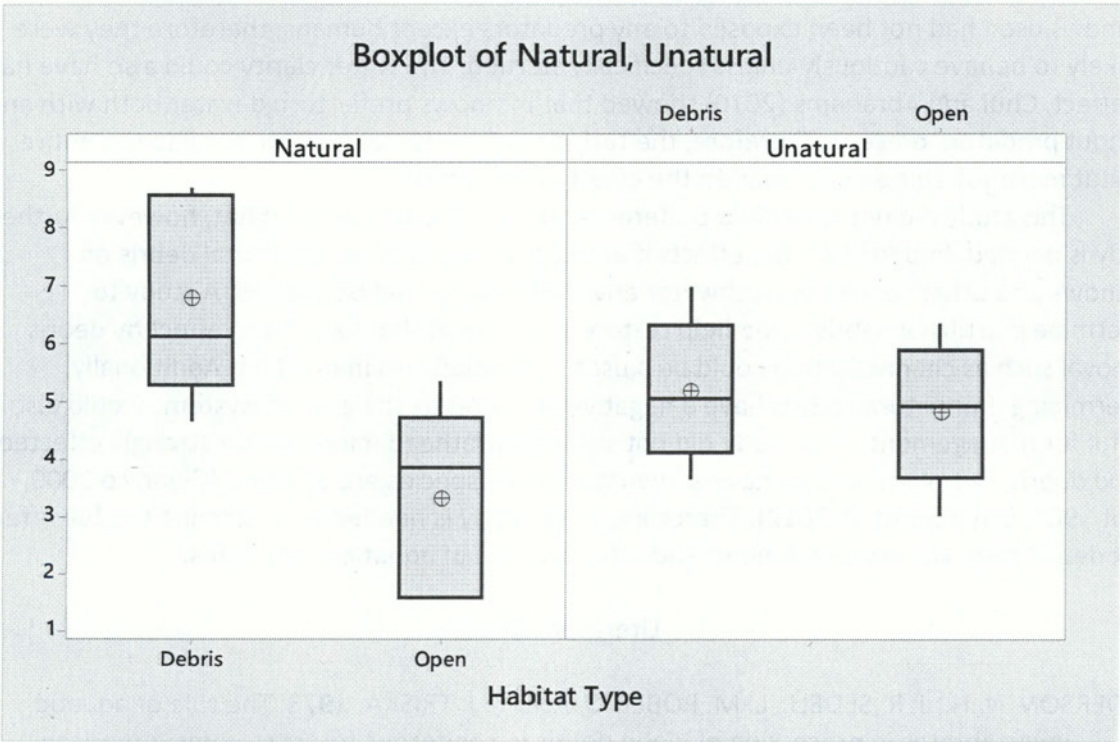

Figure 1- boxplots of mean occurrences when given a choice of either debris filled or open habitat. Mean was calculated from a total of 5 trials for each treatment with 10 minnows used in each trail. Neither natural nor unnatural tanks showed significant difference between habitat types in two-sample t-tests ($p < 0.05$). Data collected in May 2017 at Ball State University.

Discussion

The results did not suggest a preference for debris or open habitat in either the natural or unnatural experiment. This does not support the original hypothesis of the study, which expected minnows to have a preference for both types of debris. The data from the natural debris tank resulted in marginal significance, but suggests that further study and a larger sample size may result in a significant difference.

There could be several reasons why the study had these results. The results could have been the result of fluctuating temperature due to issues with the green house cooling system. Additionally, in the later weeks of the study algae had grown in the tank making the water less clear and providing a food source to the fish. The additional food source may have encouraged movement of the minnows into the more open areas or made movement more uniform throughout the tank. Without a predator in the tank the availability of food would have been the main factor that determined minnow movement in the tank (Gilliam and Fraser 1987). Additionally, because the minnows were obtained from a bait shop they were not accustomed to predators. Minnows learn threats in their environment based on the excretion of alarm hormones by other minnows (Chivers and Smith 1993, Gazdewich and Chivers 2002). The minnows used had not been exposed to any predators except humans, therefore they were unlikely to behave cautiously unless specifically startled. The water clarity could also have had an effect. Chui and Abrahams (2010) showed that minnows prefer turbid water both with and without predators present. Therefore, the turbidity of the water may have made the entire habitat more suitable and eliminated the effect of the debris.

This study did not result in a preference for debris over open habitat, however further study is needed. In particular the effects if any of plastic and other unnatural debris on minnows and other species in freshwater environments should be studied. A study to determine if artificial debris could help restore ecosystems that have been effect by debris removal such as channelization could be a useful for wildlife management. Additionally, determining if unnatural debris have a negative effect on freshwater ecosystems would also be useful for management. This study did not show that fathead minnows are strongly effected by wood debris, but other studies have shown that many species are affected (Giannico 2000, Elliot 1984, Langford et al. 2012). Therefore, more study is needed to determine the full effects that debris removal has on minnows and other aspects of aquatic ecosystems.

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